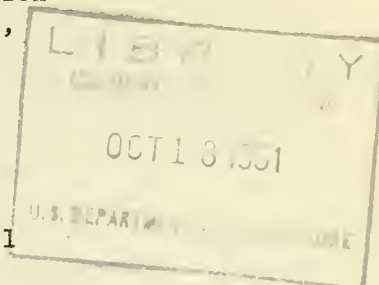


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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils,
and Agricultural Engineering



H. T. & S. Office Report No. 251

✓ Influence of Loading Temperature of Potatoes, Type
and Number of Heaters and Type of Car on
Potato Transit Temperatures
East Grand Forks, Minn. to Chicago, Ill.
January, 1951 ✓

By

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Division of Handling, Transportation and Storage of
Horticultural Crops

Report of a study made under the
Research & Marketing Act of 1946
R#320

East Grand Forks, Minnesota
July 13, 1951

INFLUENCE OF LOADING TEMPERATURE OF POTATOES, TYPE AND
NUMBER OF HEATERS AND TYPE OF CAR ON POTATO
TRANSIT TEMPERATURES--JANUARY 1951

Severely cold weather encountered during a portion of the late crop potato shipping season in the Red River Valley of North Dakota and Minnesota has resulted in a substantial amount of freezing damage in cars originating in this area. A satisfactory means of protecting potatoes from freezing in transit during very cold weather would be of value to shippers, receivers and transportation companies alike.

The present investigation was undertaken (1) to obtain knowledge on the effect of potato temperature at time of loading, and number and type of end-bunker heaters on protection from freezing, and (2) to compare two underslung heater cars--one equipped with an overhead fan and another with floor fans--with a fan car heated by two standard portable charcoal heaters.

EXPERIMENTAL EQUIPMENT AND PROCEDURE:

Nine cars were employed in this test, 6 of which were used for Part I and 3 for Part II. The list of cars together with the number and type of heaters used were as follows:

<u>Car No.</u>	<u>Number of Heaters</u>	<u>Type of Heater</u>
A-FGE 55452	2	Alcohol
B-FGE 56235	2	Charcoal
C-FGE 38971 1/	4	Alcohol
D-FGE 38008	4	Charcoal
E-FGE 38927 1/	2	Alcohol
F-FGE 38411	2	Charcoal
G-BREX 74399 2/	1	Underslung
H-BREX 74398 2/	1	Underslung
I-PFE 2710 2/	2	Charcoal

-
- 1/ Fan cars. Fans sealed in off position.
2/ Fan cars. Fans in on position.

Test Cars:

The FGE cars were all standard end bunker cars of about average condition containing $3 - 3\frac{1}{2}$ " of insulation and with no side wall racks or flues. Cars C and E were equipped with Preco fans under the floor racks which were sealed in the "off" position for this test. The BREX and PFE cars had $4 - 4\frac{1}{2}$ inches of insulation and were equipped with wall flues. Car G was equipped with Preco overhead fans while car H and I had Preco fans under the floor rack and the fans on these cars were operated in transit. These last three cars were in excellent condition. Prior to loading, the floor racks of all cars were covered with substance 60 Kraft paper except at the doorways where a space of approximately 12 inches was

left uncovered. Drains in all cars were open with drain drip caps on. This was standard procedure followed by the Western Fruit Express Company in preparing cars for potatoes during this season. The cars were preheated for 16 to 24 hours and all were at satisfactory temperatures prior to loading except car H. This car was slow in preheating making it necessary to place a hot blast heater in it before loading.

Heaters:

The Luminator-Mitchell underslung charcoal heater has been fully described in an earlier report 1/. The heaters were operated manually in accordance with the Luminator-Mitchell operating instruction manual dated December 1, 1950. The Preco thermostatically controlled alcohol heater was also described in a previous report 2/. The thermostats on these heaters were set at 40° F.

The portable charcoal heaters employed were regular 1-piece 16" Simplex heaters currently in regular use. In the car containing 4 charcoal heaters, 2 were placed in each bunker. The third heater was to be lit at 0° and the fourth at -10° F. outside air temperatures.

Commodity and Air Temperatures:

Employing distant reading electric resistance thermometers, ten commodity and two air temperatures were obtained. The thermometer bulbs were placed in the air or in potatoes in burlap sacks at the following positions:

<u>Position</u>	<u>Designation</u>
Bottom bunker west side, head and rear (potato)	BBWS-H, BBWS-R
Bottom bunker center line, head and rear (potato)	BBCL-H, BBCL-R
Bottom quarter length west side, head and rear (potato)	BQWS-H, BQWS-R
Top quarter length center line, head and rear (potato)	TQCL-H, TQCL-R
Bottom doorway, west side (potato)	BDWS
Top doorway, center line (potato)	TDCL
Bottom doorway, center line (air)	BDCL-AIR
Top doorway, center line (air)	TDCL-AIR

Since the danger of freezing damage is greatest in the layer next to the floor, thermometers were inserted in bottom layer potatoes next to the outside of the sack in order to detect possible dangerously low temperatures. The top temperatures were obtained by inserting thermometers in the uppermost potatoes of the load. Air temperatures were obtained at the bottom doorway center line just above the floor racks and at the top doorway center line about four inches from the ceiling. Commodity and air temperatures were read at terminals and other stops en route.

Gas Samples:

Copper tubing (1/4-inch O.D.) was placed in 4 cars for the purpose of

1/ H.T.&S. Report 208.

2/ Comprehensive Report on Heat Tests issued July, 1948 (AAR-USDA Tests 22, 23, 24, 25, 26, 27.).

obtaining samples of the car atmosphere for analysis. The tubing was run from the sampling positions out under the door and extended a few inches outside. Air was sampled near the bottom of the load at the doorway center line just above the floor racks and near the top of the load about six inches from the ceiling at the doorway center line position. Samples were withdrawn with an aspirator bulb into gas sampling tubes and analyzed later for CO, CO₂, O₂ utilizing a Hayes portable gas analyzer. All of the samples for gas analysis were obtained before the hatches were opened for servicing of the heaters at inspection points.

Loading and Routing:

The six cars in Test I were loaded at East Grand Forks Minnesota between 9:45 A.M. and 6:10 P.M. on January 25. The cars in Test II were loaded between 9:45 A.M. and 4:45 P.M. on January 26. All of the cars were loaded in the same way with 360 100-lb. bags of washed and waxed Triumph potatoes (figure 1). The load was a modification of the "pyramid through load" recommended by the Association of American Railroads 3/. Paper filled fabricated pads (1/2" thick), 28" x 88" were placed on the floor racks as the cars were being loaded. Complete loading data are shown in Table 1.

The cars were assembled in Grand Forks, North Dakota on the morning of January 27 and the test train departed at 12:20 P.M. The cars were routed from Grand Forks to Minneapolis, Minnesota via the Great Northern Railroad, and to Chicago, Illinois via Chicago, Burlington, and Quincy Railroad. Total elapsed time for the trip was 57 hours 15 minutes, of which 30 hours 22 minutes (53.0 per cent) was running time and 26 hours 53 minutes (47.0 per cent) was standing time. See Table 2 for trip log.

DISCUSSION OF RESULTS

Test I

Outside temperatures during loading ranged from -2° to -7° F. after which the weather became increasingly colder until a minimum of -24° was reached on January 28th and again on the 29th. While temperatures during loading were below normal, even colder weather is often encountered in this area during the winter months with temperatures falling to -20° to -30°. The temperatures encountered in transit, however, were considerably below normal, particularly during the last two days of the test when temperatures 34° to 39° below normal were recorded (figure 2).

The transit air and commodity temperatures for the cars heated with two Preco-alcohol heaters are shown graphically in figures 2 and 6. These data clearly show the inadequacy of two alcohol heaters per car in this test in protecting potatoes from freezing during severe weather. In car A (figure 2) loaded with potatoes of about 39° F. temperature, dangerously

3/ Recommended Arrangement for Loading 45,000 Pounds of Potatoes in 100 Pound Bags by the "Pyramid Through Load" Method. Assn. of Amer. Railroads Freight Container Bureau Bul. 43, Dec. 1, 1942.

low temperatures occurred on the morning following loading. After 72 hours, the average temperature of the entire bottom layer had fallen to a point where freezing could occur. Although the freezing point of potatoes is about 29°, a temperature of 31° was considered dangerously low since the sensing element of the resistance thermometer was placed in the interior of the potato and a subsequent test utilizing thermocouples showed that the temperature at a depth of 1 inch in potato tubers exposed to freezing temperatures ranged from 0.4° to 2.0° higher than at 1/4 inch depth.

As expected, loading warm potatoes offered some additional protection from freezing. Thus in Car E, also heated with two alcohol heaters but loaded with 45° F. potatoes, dangerously low temperatures did not occur in the load until 3 days after loading (figure 6). In neither of the cars heated with 2 alcohol heaters did the top layer temperatures become excessively high during the test, a maximum of only 57.0° being recorded in Car E. At 5:00 P.M. on January 28th, one heater each in Cars A and E was observed to be on pilot when inspected even though the minimum temperature in both cars was at the danger point. In an attempt to protect the load, the thermostat on each of the aforementioned heaters was raised from 40° to 45°.

Possible freezing temperatures in Car B, equipped with two standard charcoal heaters, were also encountered the morning after loading (figure 3). As in the case of Car A, the average potato temperature at loading time was approximately 39° F. Unlike Car A, however, the average bottom layer temperatures did not become too cold at any time during the test. Top commodity temperatures in Car B were somewhat higher than in those cars heated with two alcohol heaters but were not considered excessive.

Car F, also containing two standard charcoal heaters, was originally intended to have been loaded with warm potatoes. The average potato temperature at loading, however, proved to be only about 1° F. higher than Car B, thus making the two cars directly comparable. Figure 7 shows that commodity temperatures in this car were very satisfactory during the entire test with the lowest temperature recorded being 35.5° and the highest 62.5°. Since this warmer car burned less fuel and commodity loading temperatures were not materially different, this data serves to illustrate the difference that may occur between cars of the same general specifications. The reason for such a difference in the behavior of these two cars was not apparent but may have been due to differences in the amount of moisture in the insulation, thus affecting its efficiency, or to the relative tightness of the two cars.

Car C, equipped with 4 alcohol heaters (2 in each bunker), with thermostats set at 40° F., provided adequate protection against freezing damage and probably more than was necessary since the two rear heaters burned intermittently or on pilot during the latter half of the test while the head end heaters were burning intermittently during the last 29 hours (figure 4). In addition top layer temperatures rose considerably higher than desirable although no adverse effects on the potatoes were noted at destination. Potato temperatures on the bottom layer were quite uniform during the entire test. Top layer temperatures rose rapidly following loading with the rate of increase declining as colder weather was encountered. Shortly after the departure of the test train, the average top layer temperature decreased slowly with the advent of still colder weather and rose again rather sharply as higher outside temperatures were encountered during

the last 6 hours of the test. Total fuel consumption for Car C was 27.25 gal. as compared with 17.25 and 15 gal. for Car A and E, respectively equipped with 2 alcohol heaters each.

The 4 standard charcoal heaters used for heating Car D (2 in each bunker) while affording adequate protection of the lading against freezing resulted in excessively high top commodity temperatures when operated on the arbitrary system of lighting the 3rd heater at 0° F. and the 4th at -10° F. Top commodity temperatures rose very rapidly following loading with a temperature of 79.5 maximum being reached approximately 48 hours later. One heater was darkened at 9:00 P.M. on January 26 by pushing in the slide thus precluding the delivery of additional fuel from the magazine to the fire box. The slide on this heater had later been pulled out, however, and the heater was observed to be burning the following morning. Although this heater was again darkened, potato temperatures the following day, January 28, had not changed materially. In order to guard against overheating, the 3rd heater was darkened at this time. Continued severe weather prevailed following the darkening of the 3rd heater and by the next morning the minimum temperature in the car had dropped to the danger point. As the outside temperature rose on January 29th so did the bottom layer temperatures within the car. Examination on arrival revealed no adverse effects on the potatoes in the top layer which were exposed to excessively high temperatures during transit. Total fuel consumed during the test was 168 lbs. compared with 145 and 113 lbs. burned in the cars with two standard charcoal heaters. (Cars B and F respectively).

Test II

In the second part of the test, two Luminator-Mitchell underslung charcoal heater cars, one with overhead fans and one with fans under the floor racks, were compared with a regular fan car of comparable condition equipped with 2 standard portable charcoal heaters. These cars were in excellent condition and had 4-4½ inches of insulation and wall flues.

The cars were loaded at East Grand Forks on January 26th where outside temperatures ranged from -7° to -13°F. Following loading, these cars were handled the same way as the cars in Test I, being assembled in the test train at Grand Forks that evening.

As can be seen in figures 8 and 9, the cars equipped with underslung heaters afforded the potatoes ample protection against freezing with the exception of one part of Car H which showed freezing temperatures within an hour after loading. This car was not only slow in preheating, as was mentioned earlier, but also maintained lower temperatures throughout most of the test. A general increase in temperature was noted during the first 12 hours of transit necessitating a decrease in the draft control in accordance with operating instructions as shown in Tables 9 and 10. Following this initial increase, temperatures were quite uniform for the remainder of the trip. Car I, comparable to the underslung heater cars, but equipped with two standard portable charcoal heaters, also provided ample protection of the load from freezing. The range in commodity temperature between the top and bottom was greater in this car than is usually the case in fan cars and the temperature spread was larger than in the comparable underslung heater car. A total of 93 pounds of fuel was consumed in the portable

heaters in Car I during the test while the underslung heaters in Cars G and H burned 122 and 119 pounds respectively.

Analysis of Car Atmospheres:

The results of analysis of air samples taken from four of the test cars at the bottom doorway centerline just above the floor racks is shown in table 21. The highest CO_2 and CO content was found to be 1.5 and 0.2 percent respectively while the lowest O_2 content was 18.3 percent. Carbon monoxide could not be detected in cars heated with the alcohol heaters with the method of analysis used. While the CO_2 content was slightly higher in cars with 3 or 4 heaters burning than in those with only 2, the concentration in all cars was relatively low, indicating a rather free exchange of gasses from the car to the outside atmosphere. Samples withdrawn from cars B and D at the top doorway center line 6 inches from the ceiling were essentially the same as those from the bottom position. Burning of the heaters did not seem to be impaired by the small depletion of oxygen noted. Even greater modifications of the car atmosphere have been reported. Thus Ryall and Lutz⁴, probably using newer and tighter cars, report a concentration of 4.6 per cent CO_2 and 14.8 per cent O_2 in a charcoal heated fan car, yet noted no retardation in the burning rate of the heaters. In addition 4 charcoal or alcohol heaters per car have been used recently in a test with pears without any reported reduction in rate of burning⁵.

Conclusions:

The data obtained show rather conclusively that two portable heaters per car, either alcohol or standard charcoal, do not provide adequate protection against freezing of potatoes shipped during severely cold weather, at least in some cars. Temperatures that could cause freezing were encountered the morning after potatoes of an average temperature of 39° F. were loaded in cars heated with either portable alcohol or charcoal heaters. Many reports of freezing damage to potatoes from the Red River Valley moving during very cold weather confirm these results. The charcoal heaters were slightly superior to the alcohol heaters in heat output.

The value of loading warm potatoes as added protection against freezing was clearly demonstrated. Thus in two cars each heated with two alcohol heaters the minimum temperature in the car loaded with 39° F. potatoes was at the danger point 13 hours after loading while in the car loaded with 45° potatoes, such dangerously low temperatures were not encountered until three days after loading. An important feature in the operation of the alcohol heaters was that they were observed to be on pilot when the thermostat was set at 40° F. even though commodity temperatures were dangerously low. This suggests that the thermostat should be set at 42.5° or 45° for potatoes in non-fan cars instead of 40° as used in this test (which is the present commercial practice).

The use of 4 charcoal heaters, the 3rd lit at 0° and the 4th at -10° F. gave adequate protection from freezing but resulted in excessively high top commodity temperatures ranging up to nearly 80° F. No adverse effects of these high temperatures were noted, however. Whether this exposure to high temperatures had any subsequent effect on sprouting, shrivelling, or the development of rot in the tubers was not determined. Similar results were obtained with 4 alcohol heaters with thermostats set at 40° except that transit temperatures were 5° to 10° lower. The results of this test suggests the possibility of using 3 or 4 alcohol heaters in cars shipped during very cold weather, particularly in those of average or poorer condition. In the case of standard charcoal heaters, lighting the third heater at -10° might well be considered.

In a second part of the test fan cars in excellent condition with 4-4½ inches of insulation afforded potatoes good protection from freezing when heated with either underslung or standard portable charcoal heaters although more uniform temperatures were obtained in the cars equipped with underslung heaters. No consistent difference in temperature spread was observed between cars equipped with either overhead fans or conventional fans under the floor rack.

Analysis of the atmospheres of cars containing either 2 or 4 alcohol or charcoal heaters showed that some change had been brought about in the concentration of CO₂ and O₂ although operation of the heaters did not seem to be impaired. While a concentration of CO ranging up to 0.2 per cent was found in the charcoal heater cars, no CO could be detected in those cars heated with alcohol heaters.

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The following individuals accompanied the test cars from Grand Forks, North Dakota to Chicago, Illinois:

H. R. Hudgens, Jr.	CB&Q Railroad
Asst. Gen. Perishable Freight Agent	Chicago, Illinois

H. L. Voorhees	Assn. of American Railroads
Test Engineer	Chicago, Illinois

G. J. Jaeger	Fruit Growers Express Co.
Asst. Mechanical Supt.	Chicago, Illinois

P. H. Heinze	U. S. Dept. of Agriculture
Physiologist	Beltsville, Maryland

Herb Findlen	U. S. Dept. of Agriculture
Associate Horticulturist	East Grand Forks, Minnesota

TABLE 1. Loading Data on Test Cars Used in Heater Test--East Grand Forks, Minnesota to Chicago, Illinois--January 1951

Car Number	A	B	C	D	E	F	G	H	I
Type	FGE 55452 Non-fan	FGE 56235 Non-fan	FGE 38971 Fan 1/	TGE 38008 Non-fan	FGE 38927 Fan 1/	FGE 38411 Non-fan	BREX 74599 Fan Overhead	BREX 74398 Fan	FGE 2710 Fan
Heater	Preco- alcohol	Standard charcoal	Preco- alcohol	Standard charcoal	Preco- alcohol	Standard charcoal	Luminator- Mitchell underslung	Luminator- Mitchell underslung	Standard charcoal
Number of heaters	2	2	4	4	2	2	1	1	2
Height of load	67"	65"	64"	68"	66"	62"	63"	63"	65"
Space above load	24"	26"	24"	29"	26"	32"	25"	24"	23"
Sidewall space	6"	6 1/2"	6"	6"	6"	6"	6"	6"	6"
Sidewall racks or flues	None	None	None	None	None	None	Flues	Flues	Flues
Height of floor racks	5"	4 1/2"	7 1/2"	1 1/2"	7 1/2"	5 1/2"	7-1/4"	7"	7 1/2"
Loading started	5:00 PM	3:00 PM	11:30 AM	4:45 AM	4:30 PM	2:30 PM	9:45 AM	11:40 AM	2:15 PM
completed	5:35 PM	3:55 PM	2:30 PM	7:30 AM	6:10 PM	4:25 PM	11:30 AM	4:45 PM	3:00 PM
Average temperatures									
outside air	-40	-20	-30	-20	-70	-20	-130	-80	-70
commodity	38.70	39.20	12.10	40.60	44.60	0.40	38.80	39.90	38.80

1/ Fans sealed in "off" position.

2/ Car doors closed from 1:45 PM to 4:30 PM.

Table No. 2

Trip Log

Date	Station	Time	Time	Elapsed Time	
		Arrived	Departed	Running	Standing
Jan. 27	Grand Forks, N. D.	---	12:20 PM		
	Reynolds, N. D.	1:30 PM	1:45 PM	1-10	15
	Hillsboro, N. D.	2:30 PM	2:55 PM	45	25
	Near Gardner, N. D.	3:35 PM	3:50 PM	40	15
	Gardner, N. D.	3:55 PM	4:12 PM	05	17
	Fargo, N. D.	5:10 PM	7:00 PM	58	1-50
	Near Barnesville, Minn.	8:10 PM	8:20 PM	1-10	10
	Barnesville, Minn.	8:25 PM	8:40 PM	05	15
	Rothsay, Minn.	9:15 PM	9:45 PM	35	30
	Fergus Falls, Minn.	10:25 PM	11:25 PM	40	1-00
	Dalton, Minn.	11:50 PM	12:20 AM	25	30
28	Evansville, Minn.	1:00 AM	1:25 AM	40	25
	West Union, Minn.	2:25 AM	2:40 AM	1-00	15
	Sauk Center, Minn.	2:55 AM	3:40 AM	15	45
	St. Cloud, Minn.	5:00 AM	10:15 AM	1-20	5-15
	Robbingsdale, Minn.	12:50 PM	1:40 PM	2-35	50
	Minneapolis, Minn.	2:45 PM	3:30 PM	1-05	45
	St. Paul, Minn.	4:10 PM	7:40 PM	40	3-30
	Daytons Bluff, Minn.	8:30 PM	10:12 PM	50	1-42
	Oakland, Minn.	10:25 PM	11:59 PM	13	1-34
29	St. Croix, Minn.	12:45 AM	12:49 AM	46	04
	Burns, Minn.	1:10 AM	1:42 AM	21	32
	Prescott, Wisc.	1:49 AM	2:00 AM	07	11
	Stockholm, Wisc.	3:10 AM	3:35 AM	1-10	25
	E. Winona, Wisc.	5:03 AM	6:13 AM	1-28	1-10
	Sullivan Jct., Wisc.	8:12 AM	8:25 AM	1-59	13
	No. LaCrosse, Wisc.	8:35 AM	10:05 AM	10	1-30
	Desota, Wisc.	10:50 AM	11:15 AM	45	25
	Ferryville, Wisc.	11:45 AM	12:05 PM	30	20
	Savanna, Ill.	3:45 PM	5:10 PM	3-40	1-25
	Congress Park, Ill.	9:15 PM	9:25 PM	4-05	10
	Clyde Yard Chicago	9:35 PM	---	10	
TOTAL				30-22	26-53

Table No. 2

Heater Inspection Data

Test Code No. A Thermostat Setting 40° Heater 2 Proco-Alcohol
 Car No. FGE 55452 Fans None Drain Open Placement 1 ea. burner

Inspected at	Date	Time	OST	Heater Operation			Gals. Fuel Added			Gals. Fuel in Heater			Fuel Consumed from last inspection	Remarks
				L	H	R	L	H	R	L	H	R		
East Grand Forks, Minn.	1-25	8:00PM	-10	B	B	0	0	3.00	3.00					
East Grand Forks, Minn.	1-26	9:00AM	-13	B	B	3.00	3.00	1.75	1.75	1.25	1.25		1.25	
Grand Forks, N. D.	1-27	10:00AM	-12	B	B	2.50	3.00	2.50	2.00	2.25	2.25		2.75	
Fargo, N. D.	1-27	5:30PM	-16	B	B									
St. Paul, Minn.	1-28	5:00PM	-15	P	B		2.50	4.00	1.75	1.00	3.025			Thermostat changed to 45°
Savanna, Ill.	1-29	4:00PM	-10	B	B			2.00	2.00	2.00	2.25			
Chicago, Ill. Clyde Yard	1-29	10:00PM	-8	B	B			1.25	1.50	.75	.50			
Total Fuel Consumed													7.25	10.00

L/ B -- Full Burning
 P -- Pilot

Table No. 4

Heater Inspection Data

Test Code No. B
 Car No. FOE 86238

Fans None Drains Open

Heater 2 Simplex Charney
 Placement 1 ea. bunker

Inspected at	Date	Time	OST	Heater Operation	Fuel Added	Fuel in Heater	Fuel Consumed from last Inspection	Remark
			P.	H	R	H	R	H
East Green Forks, Minn.	1-27	8:00PM	-10	B	-	28	28	-
East Green Forks, Minn.	1-28	9:00AM	-13	B	11	33	18	25
Green Forks, N. D.	1-27	10:00AM	-12	B	18	32	10	16
Green Forks, N. D.	1-27	1:30PM	-10	B	-	00	00	00
St. Paul, Minn.	1-28	8:00PM	-20	B	18	20	10	0
Savannah, Ill.	1-29	4:00PM	-10	B	-	20	8	-
Chicago, Ill.	1-29	10:00PM	-8	B	0	0	8	20
Clyde Yard								
Total Fuel Consumed								66
								79

Table No. 5

Heater Inspection Data

Test Code No. C
 Ser No. FGE 38971

Thermostat Setting 100
 Fans Off Drains Open

Heater 4 Pressure 41.00
 Placement 2 ea. back

Inspected at	Date	Time	OST	°F.		Heater Operation	Gals Fuel Added	Gals Fuel in Heater	Fuel Consumed from last inspection
				H	R	H	R	H	R
East Grand Forks, Minn.	1-25	8:00PM	-10	Rt. Lft.	B	Lft.	0	0	5.00 2.50
				Lft. B	B	0	0	2.25 5.00	0.00 0.00
East Grand Forks, Minn.	1-26	9:00AM	-13	Rt. B	B	1.75 3.00	3.00 1.50	2.00 1.00	1.00 1.25
				Lft. B	B	3.75 1.00	1.00 3.75	1.25 1.25	1.25 1.25
Grand Forks, N. D.	1-27	10:00AM	-12	Rt. B	B	2.50 2.25	2.50 2.75	2.25 2.25	2.50 2.50
				Lft. B	B	2.50 2.25	2.50 2.75	2.25 2.25	2.50 2.50
Fargo, N. D.	1-27	5:30PM	-16	Rt. B	P	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
				Lft. B	P	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
St. Paul, Minn.	1-28	5:00PM	-15	Rt. B	F	2.50 0.00	2.00 4.25	3.00 0.75	0.50 0.50
				Lft. B	B	2.50 0.00	2.00 4.25	3.00 0.50	0.50 0.50
Savanna, Ill.	1-29	4:00PM	-10	Rt. F	F	0.00 0.00	2.75 4.25	1.75 0.25	0.25 0.25
				Lft. F	F	0.00 0.00	2.75 4.25	1.75 0.25	0.25 0.25
Chicago, Ill.	1-29	10:00PM	-8	Rt. F	B	0.00 0.00	2.25 4.25	0.50 0	0 0
				Lft. F	B	0.00 0.00	2.00 4.25	0.75 0	0 0

Total Fuel Consumed

Rt. 9.50 4.25
 Lft. 9.00 4.50

1/ B Full burning

P - Pilot

Table No. 6

Heater Inspection Data

Test Code No. D
Case No. FCF 18008

Range N. D. Drains Open

Heater 4 Simplex Charcoal
Pilot 2 ea. burner

Inspected at	Date	Time	CST	Heater Operation		Fuel Added		Fuel in Heater		Fuel Consumed from last inspection		Remarks
				F.	H	R	H	R	H	R		

East Grand Forks, Minn.

1-25

8:00 PM

-20

Rt. Lt. B

P

28

28

28

28

28

28

28

28

28

28

28

East Grand Forks, Minn.
See Note 2

1-25

9:00 AM

-13

Rt. Lt. B

B

13

13

13

13

13

13

13

13

13

13

13

Grand Forks, N. D.

1-27

11:00 AM

-12

Rt. Lt. B

3

12

12

12

12

12

12

12

12

12

12

12

Grand Forks, N. D.

1-27

3:30 PM

-14

Rt. Lt. B

14

14

14

14

14

14

14

14

14

14

14

14

St. Paul, Minn.

1-28

8:00 PM

-20

Rt. Lt. B

20

20

20

20

20

20

20

20

20

20

20

20

St. Paul, Minn.

1-29

1:00 PM

-14

Rt. Lt. B

14

14

14

14

14

14

14

14

14

14

14

14

Chicago, Ill.
Clyde Lane

1-29

10:00 PM

-8

Rt. Lt. B

8

8

8

8

8

8

8

8

8

8

8

8

Total Fuel Consumed

Rt. Lt. B

43

50

18

51

All soaked down well

All soaked down well

R-R. soaked again

R-R. soaked

2/ B - Burning
D - Dark
Heater darkened Grand Forks, 1-26, 9:00 AM. Found burning when examined 1-27, 10:00 AM.

Table No. 7

Heater Inspection Data

Test Code No. E
Car No. PGE 389297

Thermostat Setting 40°
Fans Off Drains Open

Heater 2 Penn-Air
Placement 1 ea. bunker

Inspected at	Date	Time	OST	Heater Operation <u>1/</u>		Gals. Fuel Added	Gals. Fuel in Heater		Fuel Consumed from last inspection	Remarks
				F.	H	R	H	R	H	R
East Grand Forks, Minn.	1-25	8:00PM	-10	B	B	--	3.00	3.00	--	--
East Grand Forks, Minn.	1-26	9:00AM	-13	B	B	2.75	2.00	1.50	1.00	1.50
Grand Forks, N. D.	1-27	10:00AM	-12	B	B	2.25	2.75	2.50	2.00	2.25
Fargo, N. D.	1-27	5:30PM	-16	B	F	--	--	--	--	--
St. Paul, Minn.	1-28	5:00PM	-15	B	F	2.75	2.25	4.25	2.75	.75
										Thermostat changed to 45°
Savanna, Ill.	1-29	4:00PM	-10	B	B	--	2.50	3.00	2.50	1.25
Chicago, Ill.	1-29	10:00PM	-8	B	B	--	2.50	2.00	0	1.00
Clyde Yard										
Total Fuel Consumed										8.25 6.75

1/ B - Full burning
P - Pilot

Table No. 8

Heater Inspection Data

Test Code No. F
Car No. FGE 38737

Fans None Drains Open

Heater 2 Simplex Charcoal
Placed in 2 500 lb. tank

Inspected at	Date	Time	OST F, H	Heater Oper - thru 1/		Lbs. Fuel Added	Lbs. Fuel in Heater		Fuel Consumed from last Inspection	Remarks
				F	H	R	H	R		
East Grand Forks, Minn.	1-25	8:00PM	-10	B	B	00	28	28	00	00
East Grand Forks, Minn.	1-26	9:00AM	-13	B	B	10	9	18	19	10
Grand Forks, N. D.	1-27	10:00AM	-12	B	B	15	18	13	11	15
Fargo, N. D.	1-27	5:30PM	-16	B	B	00	00	00	00	00
St. Paul, Minn.	1-28	8:00PM	-20	B	B	10	20	12	8	16
Savanna, Ill.	1-29	4:00PM	-11	B	B	00	00	00	00	00
Chicago, Ill. Clyde Yard	1-29	10:00PM	-8	B	B	00	00	20	10	8

Total Fuel Consumed

49 64

1/ B - Burning



Table No. 2

Heater Inspection Data

Test Code No. Q
Car No. BREX 74399

Draft Setting 7
Fans On Drains Open

Heater Lumina-tor-Mitchell Under-slung
Placement Under-slung at doorway

Inspected at	Date	Time	OST	Liquidometer Reading (°F)	Heater Operation	Lbs Fuel Added	Lbs Fuel in Heater	Fuel Consumed from last inspection	Remarks
			°F.	Top	Bottom				
East Grand Forks, Minn.	1-26	9:00AM	-13	34	32	B	80	80	Draft set at 7
Grand Forks, N. D.	1-27	10:00AM	-12	80	80	B	42	38	42
Fargo, N. D.	1-27	5:30PM	-15	38	35	B	80	80	Draft reduced to 5
St. Cloud, Minn.	1-28	5:00AM	-22	43	47	B	80	80	Draft reduced to 3
St. Paul, Minn.	1-28	8:00PM	-20	41	42	B	40	80	40
LaCrosse, Wisc.	1-29	8:30AM	-18	39	42	B	80	80	80
Savanna, Ill.	1-29	4:00PM	-10	40	43	B	80	80	80
Chicago, Ill. Clyde Yard	1-29	10:00PM	-8	40	42	B	80	40	40
Total Fuel Consumed								122	

1 / B. - Burning



Table No. 10

Heater Inspection Data

Test Code No. H
Car No. BREX 74,198

Draft Setting 7
Fans On Drain Open

Heater Location 2-Mitchell Underslung at 100%
Placement Underslung at 100%

Inspected at _____ Date _____
Liquidometer Reading (°F) _____
Heater lbs. Fuel in Consumed _____
Operation 1/ Added Heater from last inspection _____
Remarks _____

of Top Bottom

East Grand Forks, Minn.	1-26	9:00AM	-13	00	00	B	00	40	00	Draft set at 7
Grand Forks, N. D.	1-27	10:00AM	-12	36	36	B	40	40	40	Draft reduced to 5
St. Cloud, Minn.	1-28	9:00AM	-22	42	42	B	00	00	00	
St. Paul, Minn.	1-28	8:00PM	-20	40	44	B	11	00	19	
LaCrosse, Wisc.	1-29	8:30AM	-18	38	42	B	00	00	00	
Savanna, Ill.	1-29	4:00PM	-10	44	45	B	20	00	20	
Chicago, Ill. Clyde Yard	1-29	10:00PM	-8	42	45	B	00	40	40	

Total Fuel Consumed 119

1/ B - Burning



Table No. 11

Heater Inspection Data

Test Code No. 1
Car No. PFF 2770

Fans On Drains Open

Heater 2 Simplex Charcoal
Placemat 1 ea. brick

Inspected at	Date	Time	OST	Heater Operation 1/	Lbs. Fuel Added	Lbs. Fuel in Heater	Fuel Consumed from last Inspection	Remarks	
			Of.	H	R	H	R	H	R
East Grand Forks, Minn.	1-26	9:00AM	-13	B	B	28	28	00	00
Grand Forks, N. D.	1-27	10:00AM	-12	B	B	15 17	13 13	15	15
Fargo, N. D.	1-27	5:30PM	-16	B	B	00	00	00	00
St. Paul, Minn.	1-28	8:00PM	-20	B	B	20 17	8 11	20	17
Savanna, Ill.	1-29	4:00PM	-10	B	B	00	00	00	00
Chicago, Ill. Clyde Yard	1-29	10:00PM	-8	B	B	0	0 18 12	10	16
									Shaken down well.

Total Fuel Consumed 45 48

1/ B - Burning



TABLE No. 1.

Corrected Air and Condenser Temperature

Commodity Potatoes

Call No. 1 FGE 420.2
Holds 2 Pict-A-Index

Station	Date Time	OST	TDCL	BDCL	BWWS	BWWS	BQWS	BQWS	BDWS	BDWS	EBCL	BECL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.	
	Jan.		9P.	Air	Air	H	R	H	R	Loaded Jan. 25 5:00 - 5:35 PM					H	R				
F. Grand Forks	25	7:30P	-10	345	340	350	350	340	355	340	350	370	415	435	395	43.0	34.0	41.5	37.5	
E. Grand Forks	26	8:30A	-13	585	335	340	335	320	340	300	335	355	455	490	425	49.0	30.0	46.0	33.5	
H. Grand Forks	26	9:30P	=	591	530	345	335	310	330	300	340	340	495	510	450	50.0	30.0	48.0	37.5	
Grand Forks	27	9:15A	-14	610	385	325	320	340	325	300	340	340	525	530	435	53.0	31.0	45.0	36.0	
Fargo	27	5:30E	-16	565	330	320	310	320	310	300	320	340	525	530	440	53.0	32.0	50.0	41.5	
St. Cloud	28	5:00A	-22	570	330	300	305	310	315	300	305	335	455	520	440	52.0	30.0	48.0	31.5	
St. Paul	28	4:30P	-15	570	310	290	295	295	315	295	300	310	480	505	420	50.5	29.0	47.0	30.0	
IAGrosse	29	8:30A	-18	600	325	300	300	300	315	300	300	315	515	530	440	53.0	30.0	45.5	30.4	
Savanna	29	4:00P	-10	625	340	305	305	310	340	305	345	320	530	545	450	54.5	30.5	50.8	31.3	
Chicago Clyde Yard	29	10:00P	=	8	630	370	315	310	315	345	315	310	325	545	550	460	55.0	31.0	51.8	32.1

Table No. 13

Corrected Air and Commodity Temperatures

Commodity Potatoes

Car No. B FGE 76235
Heater 2 Simplex Charcoal

Station	Date	Time	OST	TDCL	BDCL	BBWS	BBWS	BQWS	BQWS	BDWS	BBCL	BBCL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE.	AVE.
	Jan.		OF.	Air	Air	H	R	H	R	H	R	H	R					TOP.	BOT.
E. Grand Forks	25	7:30P	-10	570	380	355	370	345	340	360	380	365	420	450	410	45.0	34.0	42.7	35.9
E. Grand Forks	26	8:30A	-13	545	380	335	330	320	305	350	400	325	460	480	435	48.0	30.5	45.8	33.8
E. Grand Forks	26	5:30P	-9	570	380	335	325	330	300	340	360	305	480	500	445	50.0	30.0	47.5	32.7
Grand Forks	27	9:15A	-14	605	370	335	330	315	305	345	350	310	500	530	465	53.0	30.5	49.8	32.7
Fargo	27	5:30P	-16	640	370	325	335	320	310	360	335	315	510	540	485	54.0	31.0	51.2	32.9
St. Cloud	28	5:00A	-22	700	375	350	355	330	320	370	365	340	540	580	510	58.0	32.0	54.3	34.7
St. Paul	28	4:30P	-15	675	375	350	355	360	325	380	---	330	550	595	515	59.5	32.5	55.3	35.0
LaCrosse	29	8:30A	-18	650	365	340	340	325	310	365	360	315	530	570	510	57.0	31.0	53.7	33.6
Seavenna	29	4:00P	-10	705	375	350	365	340	315	380	---	330	560	600	525	60.0	31.5	56.2	34.7
Chicago Clyde Yard	29	10:00P	-8	680	430	360	370	360	330	390	---	340	570	620	545	62.0	33.0	57.8	35.8



Table No. 14

Corrected Air and Commodity TemperaturesCommodity PotatoesCar No. C FGE 38977
Heater 4 Proco-Alcohol

Station	Date Time	OST	TDCL	BDCL	BWWS	BWWS	BQWS	BQWS	BDWS	BDWS	BBCL	BBCL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.
	Jan.	°F.	Air	Air	H	R	H	R	H	R	H	R	H	R					
			Loaded Jan. 25 11:30 AM - 2:30 PM																
E. Grand Forks	25 7:40P	-10	520	390	325	345	375	360	385	350	335	460	485	435	48.5	32.5	46.0	35.4	
E. Grand Forks	26 8:30A	-13	700	410	365	370	400	380	400	360	335	610	630	545	63.0	33.5	59.5	37.3	
E. Grand Forks	26 5:30P	-9	725	410	360	370	395	380	395	360	335	650	665	555	66.5	33.5	62.3	37.1	
Grand Forks	27 9:15A	-14	745	410	355	370	400	380	405	375	345	680	690	585	69.0	34.5	64.2	37.3	
Fargo	27 5:30P	-16	685	415	365	370	415	380	405	355	345	690	685	595	69.0	34.5	65.7	37.6	
St. Cloud	28 5:00A	-22	640	410	350	345	395	360	395	340	345	670	645	580	67.0	34.0	63.0	36.1	
St. Paul	28 4:30P	-15	655	400	345	340	395	355	390	335	340	650	630	575	65.0	33.5	61.8	35.7	
LaCrosse	29 8:30A	-18	615	395	325	335	375	335	380	325	340	630	615	560	63.0	32.5	60.2	34.5	
Savanna	29 4:00P	-10	640	405	325	340	475	335	380	320	340	630	615	565	63.0	32.0	60.3	35.9	
Chicago Clyde Yard	29 10:00P	-8	665	405	335	370	420	360	390	335	365	670	615	565	67.0	33.5	61.7	36.8	



Table No. 15

Corrected Air and Commodity Temperatures

Commodity PotatoesCar No. D FGE 38008
Heater 4 Simplex Charcoal

Station	Date Time	OST	TDCL	BDCL	BHWS	BBWS	BQWS	BQWS	BDWS	BBCL	BBCL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.
	Jan.	°F.	Air	Air	H	R	H	R	H	R	H	R	H	R				
E. Grand Forks	25 7:40P	-10	515	360	380	380	370	380	385	390	380	485	460	425	48.5	37.0	45.7	38.7
					Loaded Jan. 25 9:45 AM - 11:30 AM													
E. Grand Forks	26 8:30A	-13	775	390	400	400	395	395	400	390	380	645	695	570	69.5	38.0	63.7	39.4
E. Grand Forks	26 5:30P	-9	775	400	400	400	395	380	380	390	390	710	755	540	75.5	38.0	66.8	39.1
Grand Forks	27 9:15A	-14	820	400	390	410	405	380	370	390	390	765	795	685	79.5	37.0	74.8	39.1
Fargo	27 5:30P	-16	825	420	400	425	405	400	365	395	400	775	795	705	79.5	36.5	75.8	39.3
St. Cloud	28 5:00A	-22	845	430	410	425	400	400	390	405	400	790	795	720	79.5	39.0	76.8	40.4
St. Paul	28 4:30P	-15	845	425	410	400	405	395	395	400	390	780	785	715	78.5	39.0	76.0	39.9
LaGrasse	29 8:30A	-18	700	410	310	320	320	330	365	370	320	735	740	665	74.0	31.0	71.3	33.4
Savanna	29 4:00P	-10	740	420	345	360	355	350	380	365	350	735	730	660	73.5	34.5	70.3	35.8
Chicago Clyde Yard	29 10:00P	-8	775	450	380	385	385	375	400	380	370	725	740	670	74.0	37.0	71.2	38.2



Table No. 16

Observed Air and Commodity Temperatures

Commodity Potatoes

Cen No. E FOF 38927
Hwy 2 P2220-A100007

Station	Date Time	OST	TDCL	BDCL	BMWS	BMWS	BQWS	BQWS	BDWS	BBCL	BBCL	TQCL	TQCL	IDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.
Jan.		OF.	Air	Air	H	R	H	R	H	R	H	R						
E. Grand Forks	28 7:40P	-10	610	480	405	405	450	423	452	405	415	505	495	505	50.5	40.5	50.2	42.3
E. Grand Forks	26 8:30A	-13	645	460	405	395	450	430	455	370	385	425	435	425	53.4	38.0	52.8	41.5
E. Grand Forks	26 5:30P	-9	645	445	385	385	435	420	415	370	370	550	545	525	55.0	37.0	54.0	39.8
Grand Forks	27 9:15A	-14	655	440	365	385	420	405	410	350	360	535	535	530	55.5	35.0	54.0	38.5
Fargo	27 5:30P	-16	585	430	365	370	425	405	390	345	360	545	570	540	57.0	34.5	55.2	38.0
St. Cloud	28 5:00A	-22	565	410	315	320	385	330	370	325	360	540	535	520	54.0	31.5	53.2	34.4
St. Paul	28 4:30P	-15	570	395	310	310	370	325	360	330	355	530	525	505	53.0	31.0	52.0	33.7
LaCrosse	29 8:30A	-18	610	380	305	315	370	345	370	325	320	525	535	510	53.5	30.5	52.3	33.6
Sevanna	29 4:00P	-10	645	390	315	330	390	355	385	325	325	535	550	525	55.0	31.5	53.7	34.6
Chicago Clyde Yard	29 10:00P	-8	655	410	325	345	410	365	395	370	340	535	555	535	55.5	32.5	54.2	36.4

Loaded Jan. 25 4:30 PM - 6:10 PM



Table No. 17

Corrected Air and Commodity Temperatures

Commodity PotatoesCar No. F FGE 3847Heater 2 Simplex Charcoal

Station	Date Time Jan.	OST	TDCL	BDCL	BWMS	BWMS	BQWS	BQWS	BQWS	BDWS	BBCL	BBCL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.
					H	R	H	R	H	R	H	R							
Loaded Jan. 25 2:30 PM - 4:25 PM																			
E. Grand Forks	25 7:40P	-10	575	400	405	390	395	400	395	410	410	455	460	430	46.0	39.0	44.8	40.1	
E. Grand Forks	26 8:30A	-13	555	390	395	380	395	385	380	390	370	500	480	460	50.0	37.0	48.0	38.5	
E. Grand Forks	26 5:30P	-9	595	390	385	380	395	395	380	390	360	515	520	490	52.0	36.0	50.8	38.4	
Grand Forks	27 9:15A	-14	635	390	375	380	395	395	380	400	360	555	560	530	56.0	36.0	54.8	38.4	
Fargo	27 5:30P	-16	695	390	370	380	400	395	380	415	355	575	585	545	58.5	35.5	56.8	38.5	
St. Cloud	28 5:00A	-22	695	395	385	390	410	415	410	425	365	600	610	570	61.0	36.5	59.3	40.0	
St. Paul	28 4:30P	-15	705	390	385	390	410	415	395	430	360	595	605	570	60.5	36.0	59.0	39.8	
LaCrosse	29 8:30A	-13	625	390	365	380	395	405	385	410	355	580	595	555	59.5	35.5	57.7	38.5	
Savanna	29 4:00P	-10	660	390	375	380	400	410	390	420	350	585	590	555	59.0	35.0	57.7	38.9	
Chicago Clyde Yard	29 10:00P	-8	675	400	385	400	420	425	410	430	365	595	625	570	62.5	36.5	59.7	40.5	

Table No. 18

Corrected Air and Commodity Temperatures

Commodity	Station	Date	Time	OST	°F.	Car No. G BREX 6222 Overboard Fan Heating										MAX.	MIN.	AVE. TOP	AVE. BOT.	
						TDCL	BDCL	BWWS	EBWS	BQWS	BDWS	BBCL	TBCL	TQCL	TDCL					
																				Air
Loaded Jan. 26 9:45 AM - 11:30 AM																				
E. Grand Forks		25	5:30P	- 3	410	410	360	350	425	500	395	460	410	420	410	400	55.0	35.5	41.0	44.0
Grand Forks		27	9:15A	-14	405	420	380	345	455	505	440	450	405	435	415	405	50.5	34.5	41.0	42.5
Fargo		27	5:30P	-16	470	425	445	405	485	560	460	470	440	465	430	420	56.0	40.5	43.8	45.5
St. Cloud		28	5:00A	-22	465	455	490	440	485	560	475	510	460	475	450	455	56.0	44.0	46.0	48.5
St. Paul		28	4:30P	-15	445	455	495	420	485	555	460	495	450	455	435	425	55.5	42.0	43.8	48.0
LaCrosse		29	8:30A	-18	405	435	460	395	460	520	425	470	430	440	420	410	52.0	39.5	42.3	45.1
Savanna		29	4:00P	-10	430	435	460	415	460	530	440	475	435	445	430	415	53.0	41.5	43.0	45.9
Chicago Clyde Yard		29	10:00P	- 8	430	495	465	450	465	535	440	470	450	450	435	420	53.5	42.0	43.5	46.8

Table No. 19

Corrected Air and Commodity TemperaturesCommodity PotatoesCar No. H BREX 74398
Fau
Heater Luminator-Mitchell unloading

Station	Date Time	CST	TDCL	BDCL	BMWS	BMWS	BMWS	BMWS	BDWS	BBCL	BBCL	TQCL	TQCL	TDCL	MAX.	MIN.	AVE. TOP	AVE. BOT.
	Jan.	°F.	Air	Air	H	R	H	R	H	R	H	R						
E. Grand Forks	26 5:30P	-9	370	365	310	280	400	370	360	330	330	405	415	375	41.5	28.0	39.8	34.0
	Loaded Jan. 26 11:40 AM - 4:45 PM																	
Grand Forks	27 9:15A	-14	375	365	330	300	---	370	385	325	320	405	400	375	40.5	30.0	39.3	33.8
Fargo	27 5:30P	-16	420	385	325	315	---	410	425	370	365	425	415	400	42.5	31.5	41.3	36.8
St. Cloud	28 5:00A	-22	435	405	400	380	---	430	440	420	410	450	440	420	45.0	38.0	43.7	41.3
St. Paul	28 4:30P	-15	430	400	395	375	---	440	445	425	405	445	430	415	44.5	37.5	43.0	41.4
LaCrosse	29 8:30A	-18	405	400	390	370	---	415	420	425	415	430	415	405	43.0	37.0	41.7	40.6
Savanna	29 4:00P	-10	455	435	415	440	---	440	450	440	425	475	455	420	47.5	41.5	45.0	43.5
Chicago Clyde Yard	29 10:00P	-8	455	435	440	425	---	450	460	450	440	470	455	430	47.0	42.5	44.4	44.0



Table No. 20

Corrected Air and Commodity Temperatures

Commodity PotatoesCar No. 1 PFE 2770 Fat
Heater 2 Simplex Charcoal

Station	Date Time	OST	TDCL	BDCL	Loaded Jan. 26 2:15 PM - 3:00 PM												MAX.	MIN.	AVE. TOP	AVE. BOT.
					OF.	Air	Air	H	R	H	R	H	R	H	R					
E. Grand Forks	26 5:30P	- 9	600	385		385	375	350	380	380	370	390	485	465	470	48.5	35.0	47.3	37.6	
Grand Forks	27 9:15A	-14	625	385		370	375	360	395	380	365	370	565	550	540	56.5	36.0	55.2	37.4	
Fargo	27 5:30P	-16	600	405		390	385	370	400	395	375	380	535	540	535	54.0	37.0	53.7	38.5	
St. Cloud	28 5:00A	-22	630	445		445	420	405	425	440	415	415	580	575	570	58.0	40.5	57.5	42.4	
St. Paul	28 4:30P	-15	665	445		450	430	415	440	435	420	420	610	605	595	61.0	41.5	60.3	43.0	
LaCrosse	29 8:30A	-18	570	445		460	445	435	455	455	430	435	550	565	565	56.5	43.0	56.0	44.5	
Savanna	29 4:00P	-10	600	485		490	475	450	475	485	455	455	560	565	565	56.5	45.0	56.3	46.9	
Chicago Clyde Yard	29 10:00P	- 8	670	505		520	490	470	490	515	475	480	585	590	580	59.0	47.0	58.5	49.1	



Table No. 21

Effect of Number and Type of Heaters on the Car Atmosphere

CAR B--2 CHARCOAL HEATERS						CAR D--4 CHARCOAL HEATERS					
DATE	TIME	HEATERS OPERATING ^{1/}	CO ₂	O ₂	CO	DATE	TIME	HEATERS OPERATING ^{1/}	CO ₂	O ₂	CO
			Per cent	Per cent	Per cent				Per cent	Per cent	Per cent
1/26	3:30P	2 burning	0.5	19.9	0-0.1	1/26	3:30P	3 burning & 1 intermittent	1.1	19.4	0-0.1
1/28	4:30P	2 burning	1.1	19.6	0.2	1/28	4:30P	3 burning	1.4	18.5	0.2
1/29	10:00P	2 burning	1.2	18.8	0.2	1/29	10:00P	2 burning	1.3	19.3	0.1

CAR E--2 ALCOHOL HEATERS						CAR C--4 ALCOHOL HEATERS					
DATE	TIME	HEATERS OPERATING ^{1/}	CO ₂	O ₂	CO	DATE	TIME	HEATERS OPERATING ^{1/}	CO ₂	O ₂	CO
			Per cent	Per cent	Per cent				Per cent	Per cent	Per cent
1/26	3:30P	2 burning	1.0	19.2	0	1/26	3:30P	4 burning	1.2	18.7	0
1/28	4:30P	2 burning (1 intermittent)	0.8	19.9	---	1/28	4:30P	4 burning (2 intermittent)	1.5	18.3	---
1/29	10:00P	2 burning	0.6	19.3	---	1/29	10:00P	4 burning intermittently	0.8	19.2	---

^{1/} Since last inspection.



FIGURE - 1

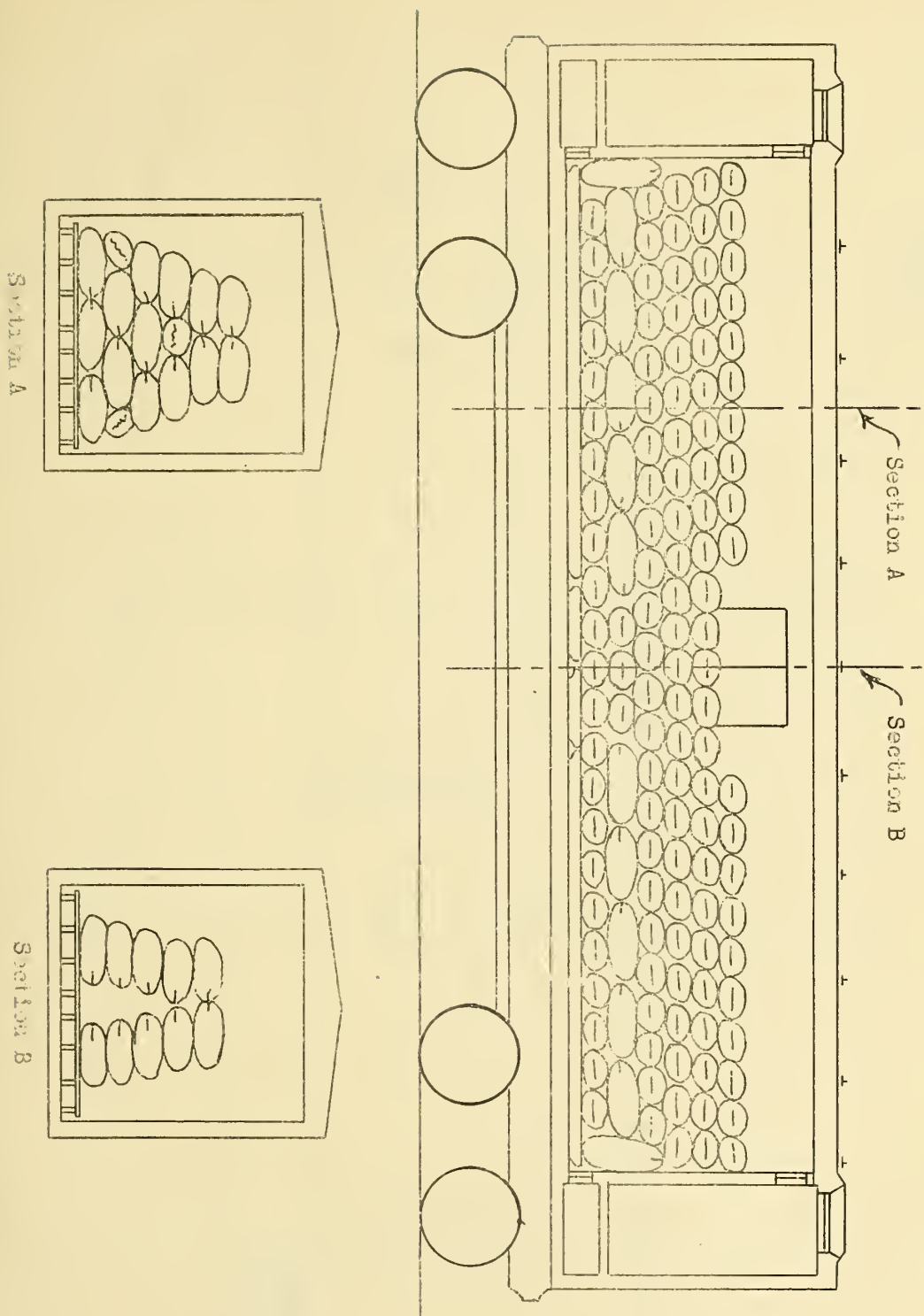
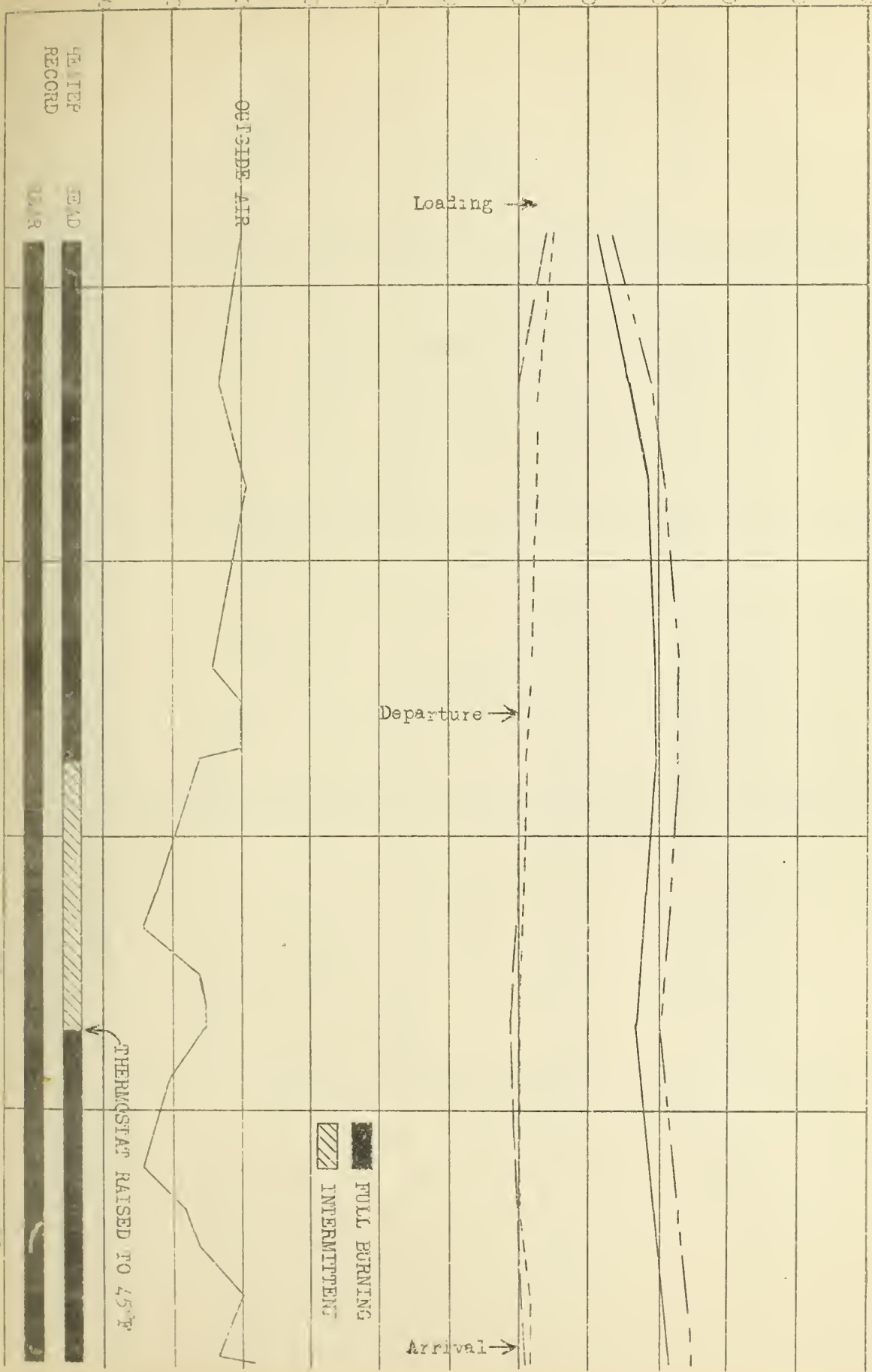


Diagram of Test Car Loading

MAX
MIN
AVE TOP
AVE BOT

FIGURE - 2
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR A
FGE 55452
2 PRECO ALCOHOL HEATERS
NON-FAN CAR



JAN 25

26

27

28

29

--- MAX
 --- MIN
 --- AVE TOP
 --- AVE BOT

FIGURE 3
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR B FGE 56235
 2 STANDARD CHARCOAL HEATERS
 NON-FAN CAR
 CPS

Loading →

Departure →

Arrival →

OUTSIDE AIR

HEATER
RECORD

HEAD
RECORD

FEET

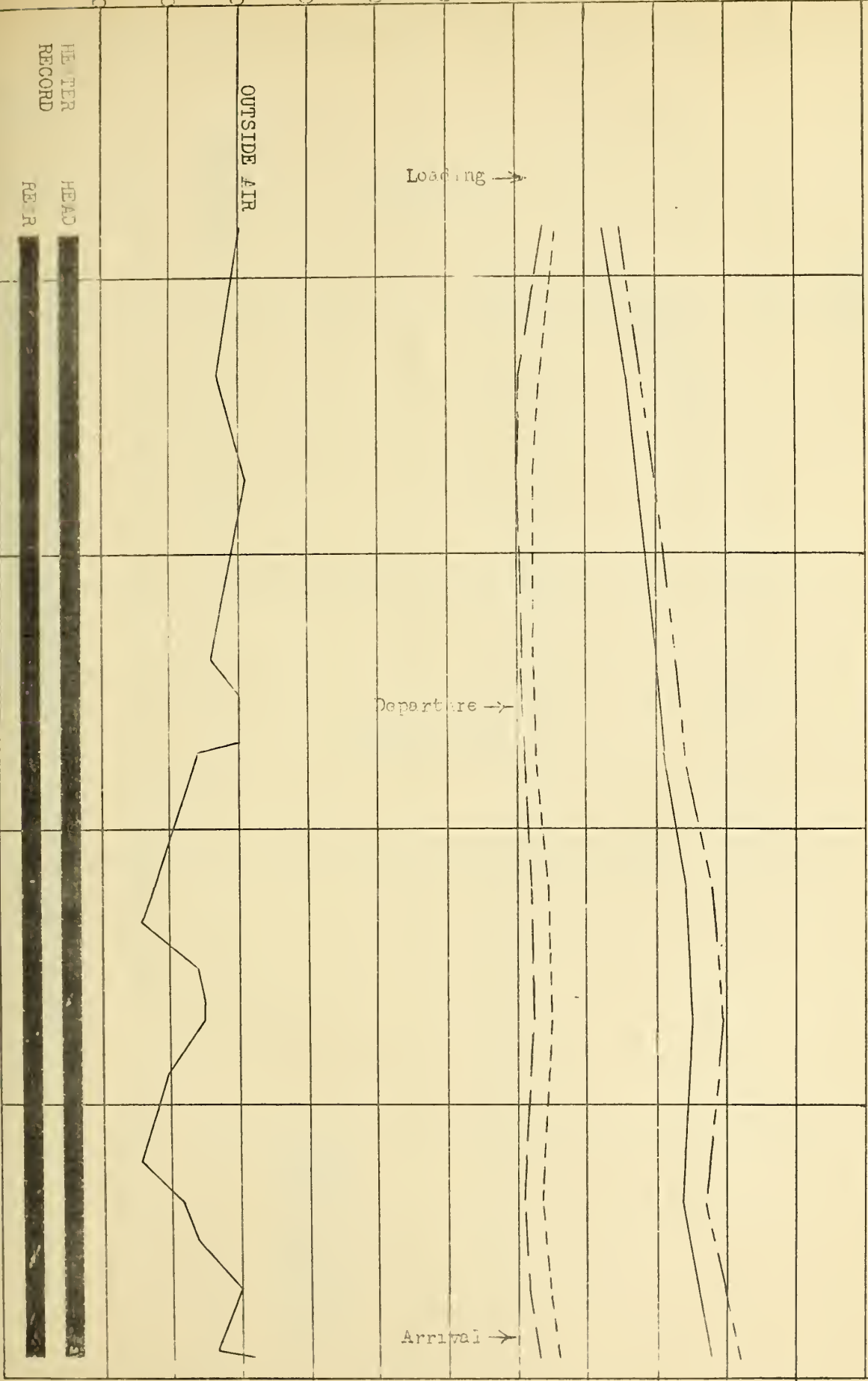
Jan. 25
1951

26

27

28

29





--- MAX
 --- MIN
 --- AVE TOP
 --- AVE SCF

FIGURE 4
TRANSHIP COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR 2 FEB 26/71
 4 PRECO ALCOHOL HEATERS
 FAN CAR-FANS OFF

TEMPERATURE (°F.)

Loading →

Departure →

Arrival →

OUTSIDE AIR

■ FULL BURNING
 ▨ INTERMITTENT

HEATER HEAD
 RECORD REAR

R L R L



JAN. 25

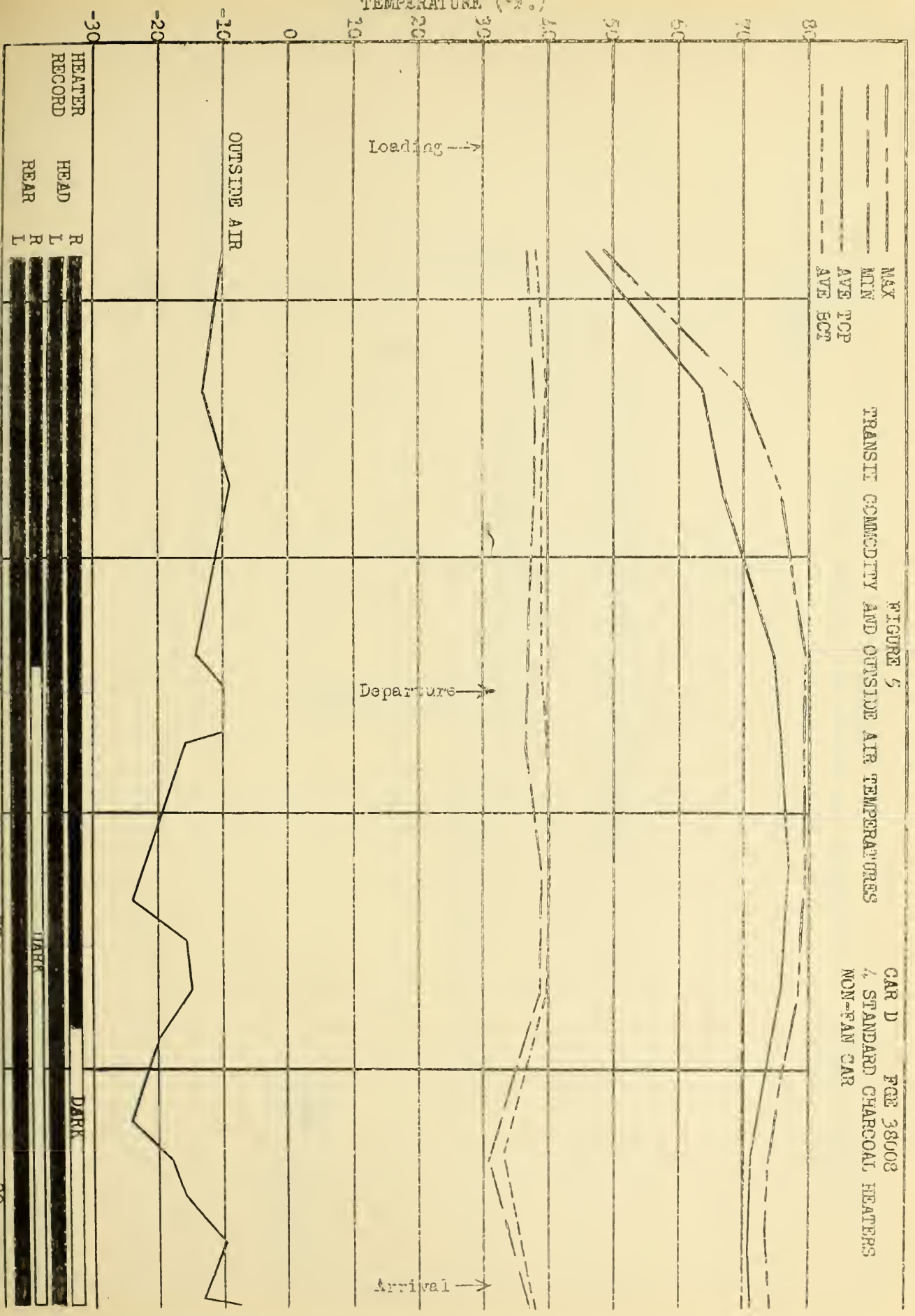
21

23

25

FIGURE 5
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR D FGE 38008
4 STANDARD CHARCOAL HEATERS
NON-FAN CAR



MAX
MIN
AVE TOP
AVE BOT

FIGURE 6
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR E FGE 38927
2 PRECO ALCOHOL
FAN CAR-FANS OFF

TEMPERATURE (°F.)

Loading →

Departure →

Arrival →

OUTSIDE AIR

FULL BURNING
INTERMITTENT

PERIODICALLY USED TO

AN.

MAX
 MIN
 AVE TOP
 AVE BOT

FIGURE - 7
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR 3
 2 STANDARD CHARCOAL HEATERS
 NON-BAY CAR
 OPS

TEMPERATURE (°F)

Loading →

Departure →

Arrival →

OUTSIDE AIR

HEAD
 HEATER
 REAR
 RECORD

JAN. 25
1951

26

27

28

29

MAX
MIN
AVE TOP
AVE BOT

FIGURE - 8
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR 3 BREX 74399
LUMINATOR-MITCHELL UNDERSTU
FAN CAR (OVERHEAD FAN)

TEMPERATURE (°F.)

Loading →

Departure →

Draft reduced to 5 →

Draft reduced to 3 →

Arrival →

OUTSIDE AIR

RECORD

1971

26

27

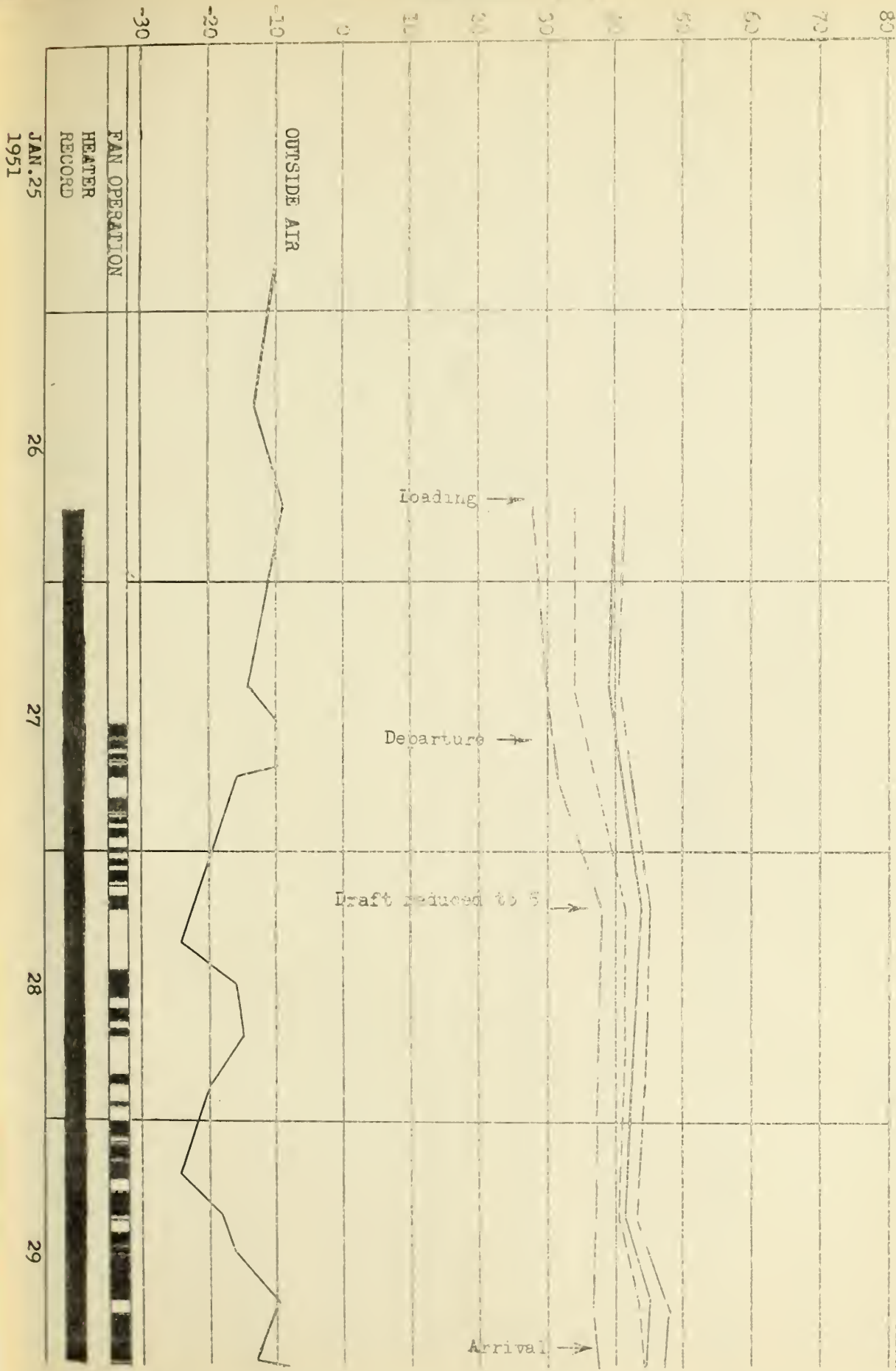
28

29

MAX
 MIN
 AVE TOP
 AVE BOT

FIGURE - 5
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR # BREX 74328
 LOUNGE-MITCHELL UNDERST
 FAN CAR (FANS UNDER FLOOR
 RACK



TEMPERATURE (°F)

MAX
MIN
AVE TOP
AVE BOT

FIGURE - 10
TRANSIT COMMODITY AND OUTSIDE AIR TEMPERATURES

CAR I PFE 2710
STANDARD CHARCOAL - 2
FAN CAR
CPS

Loading →

Departure →

Arrival →

OUTSIDE AIR

FAN OPERATION

HEAD
REAR

HEAD
REAR

JAN. 75
1975

26

27

28

29

244 (1/2)



